REMARKS

Claims 1-30 are pending in the Application. Claims 1, 11, 12, 14-16, and 19 have been amended. Claim 30 has been added. The Specification has been amended to clarify an equation. No new matter has been added. The rejections of the claims are respectfully traversed in light of the amendments and following remarks, and reconsideration is requested.

Rejection Under 35 U.S.C. § 112

Claims 1-29 are rejected under 35 U.S.C. § 112, first paragraph as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. The Examiner writes in part:

> The specification described a film deposition process including: "E/D ratios from 0.0 to about -0.05". The E/D = (UBUC-BUC)/UBUC
> Where UBUC is deposition rate [ ] with no bias; and BUC is deposition rate [ ] with bias.
> It is well known that, without bias, no etching component is present and with bias, there is an etching component. Therefore, the deposition rate [ ] without bias (UBUC) is always larger than with bias (BUC).
> The claimed invention, however, disclosed a negative E/D (-0.05).
> The negative E/D means BUC > UBUC.
> How can BUC be large[r] than UBUC while there is an etching component involve[d]?

"Table 1 . . . provides process parameter ranges . . . to form a silicon dioxide layer with a refractive index of 1.46." (Applicant's Specification as filed, page 9, lines 7-16). "UBUC is the deposition rate of the process with no wafer bias or clamping (unbiased, unclamped) and <u>no gas flow change as compared to the BUC process</u> . . . . E/D ratios from about 0.0 to about -0.05 have been achieved for void-free gap filling, <u>where the UBUC-deposited film refractive index ranges from about 1.5 to about 1.6 and the BUC-deposited film refractive index is about 1.46</u>." (Applicant's Specification as amended, paragraph beginning on page 8, line 3). Thus, when the deposition rate of the process is measured with no wafer bias or clamping and no gas flow change (e.g., no increased O_2 levels), the UBUC-deposited film refractive index changes as compared to the BUC-deposited film refractive index. Accordingly, under some conditions for low deposition rates and high aspect ratio gaps, the deposition rate with bias (BUC) may be larger than the deposition rate without bias

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(UBUC) because the films being deposited in the two cases are of different composition (more or less silicon-richness), and therefore the E/D ratio as defined by Applicant may be negative.

Rejection Under 35 U.S.C. § 102(b)

Claims 1-13, and 15-28 stand rejected as being anticipated by Papasouliotis et al. (U.S. Patent No. 6,030,881). Applicant respectfully traverses these rejections. Before addressing these rejections, Applicant notes the following features of his invention. Specifically, Applicant provides a method of filling high aspect ratio gaps without the void formations typical of the prior art. As noted by the Applicant on page 10, line 19 through page 11, line 2, a "gap with a high aspect ratio . . . is filled using HDP CVD with a minimized ratio of oxygen to silane and/or minimized oxygen flow for a selected silane flow rate." Thus, Claim 1 recites a method of filling a gap including the act of "providing a gas mixture comprised of a silicon-containing component and an oxygen-containing component; and performing an HDP-CVD process using the gas mixture to fill the gap with a dielectric, wherein the ratio of the oxygen-containing component to the silicon-containing component is substantially the minimum necessary to form the dielectric."

Papasouliotis stands in sharp contrast to such a process. Papasouliotis discloses "multiple sequential deposition and etch steps of different etch rate-to-deposition rate (etch/dep) ratios to fill high aspect ratio gaps" (Papasouliotis, col. 5, lines 19-21). The first step is a deposition step in which "[c]usps 530 begin to form at the corners of circuit elements 520 as SiO_2 layer 525 fills gap 510, as shown in FIG. 5A. Before cusps 530 close the entry to gap 510, the deposition step is stopped." (Papasouliotis, col. 5, lines 58-61). The "deposition/etching cycle is repeated as many times as necessary until the resulting gap can be filled by a conventional HDP deposition step (FIG. 5A) without void formation, as shown in FIG. 5C." (Papasouliotis, col. 6, lines 9-12). Accordingly, Papasouliotis discloses a conventional HDP deposition step in which voids will be formed if etch cycling with a different gas mixture is not performed. Nowhere does Papasouliotis disclose or suggest performing an HDP CVD process using a gas mixture to fill a gap with a dielectric, wherein the ratio of an oxygen-containing component to a silicon-containing component is substantially the minimum necessary to form the dielectric. Applicant could find no teaching or suggestion in Papasouliotis of the selecting of a flow rate of the silicon-containing

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component and the providing of a minimum flow rate of the oxygen-containing component to allow formation of a film having a refractive index of about 1.46. Applicant could find no teaching or suggestion in Papasouliotis of a gas mixture having a ratio of an oxygen-containing component to a silicon-containing component below about 1.3.

In contrast, amended Claim 1 recites a "method for filling a gap during integrated circuit fabrication, comprising . . . performing an HDP-CVD process using the gas mixture to fill the gap with a dielectric, wherein the ratio of the oxygen-containing component to the silicon-containing component is substantially the minimum necessary to form the dielectric." Therefore, because Papasouliotis does not disclose or suggest "performing an HDP-CVD process using the gas mixture to fill the gap with a dielectric, wherein the ratio of the oxygen-containing component to the silicon-containing component is substantially the minimum necessary to form the dielectric," as recited in Claim 1, Claim 1 is patentable over Papasouliotis.

Similarly, amended Claim 19 recites a "method for filling gaps during integrated circuit fabrication, comprising . . . selecting a flow rate of said silicon-containing component; providing a minimum flow rate of said oxygen-containing component to allow formation of a film having a refractive index of about 1.46; and filling said gaps by depositing said film over said gaps using said gas mixture." Therefore, because Papasouliotis does not disclose or suggest "selecting a flow rate of said silicon-containing component; providing a minimum flow rate of said oxygen-containing component to allow formation of a film having a refractive index of about 1.46; and filling said gaps by depositing said film over said gaps using said gas mixture," as recited in Claim 19, Claim 19 is patentable over Papasouliotis.

Claims 2-13 and 15-18 are dependent on Claim 1 and contain additional limitations that further distinguish them from the cited reference. Therefore, Claims 2-13 and 15-18 are allowable for at least the same reasons provided above for Claim 1. Claims 20-28 are dependent on Claim 19 and contain additional limitations that further distinguish them from the cited reference. Therefore, Claims 20-28 are allowable for at least the same reasons provided above for Claim 19. For at least these reasons, Applicant respectfully requests allowance of Claims 1-13 and 15-28.

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Rejection Under 35 U.S.C. § 103(a)

Claims 14 and 29 are rejected under 35 U.S.C. § 103(a) as being unpatentable over Papasouliotis. Claims 14 and 29 are dependent on Claims 1 and 19, respectively, and contain additional limitations that further distinguish them from the cited reference. Therefore, Claims 14 and 29 are allowable for at least the same reasons provided above for Claims 1 and 19, respectively.

New Claim

Applicant could find no teaching or suggestion in Papasouliotis of "a gas mixture comprised of oxygen-containing and silicon-containing components, said gas mixture having a ratio of said oxygen-containing component to said silicon-containing component below about 1.3," as recited in Claim 30. Accordingly, Claim 30 is patentable over Papasouliotis.

CONCLUSION

For the above reasons, pending Claims 1-30 are believed to be in condition for allowance and allowance of the Application is hereby solicited. If the Examiner should have any questions or concerns, the Examiner is hereby requested to telephone Applicant's Attorney at (949) 752-7040.

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, Washington, D.C. 20231, on August 20, 2002.

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ATTACHMENT A

This response amends the specification as follows. In the following paragraph, insertions are underlined and deletions are enclosed in brackets.

The paragraph on page 8, line 3 through line 22, is amended as follows:

In addition to a reduced oxygen to silane ratio, the method of the present invention allows for low etch-to-deposition (E/D) ratios, corresponding to greater gap-fill capability. An E/D ratio is defined by the equation:

E/D = (UBUC-BUC)/UBUC

where UBUC is the deposition rate of the process with no wafer bias or clamping (unbiased, unclamped) <u>and no gas flow change as compared to the BUC process</u>, and BUC is the deposition rate of the process with wafer bias and no clamping (biased, unclamped). In one embodiment of the present invention, as the minimized oxygen to silane ratio is used to minimize the oxygen flow rate and to reduce the silane flow rate for depositing a dielectric layer, E/D ratios have also been reduced. Reduced E/D ratios correspond to the overall sputtering rate decreasing, and the aspect ratio gapfill capability increasing. For example, E/D ratios from about 0.0 to about -0.05 have been achieved for void-free gap filling, where the UBUC<u>-deposited film</u> refractive index ranges from about 1.5 to about 1.6 <u>and the BUC-deposited film refractive index is about 1.46</u>.

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ATTACHMENT B

The amended claims with markings showing the changes are as follows:

1. (Amended) A method for filling a gap[s] during integrated circuit fabrication, comprising:

providing a gas mixture comprised of a silicon-containing component and an oxygen-containing component[s]; and

[selecting a flow rate of said silicon-containing component;

minimizing a ratio of said oxygen-containing component to said silicon-containing component, wherein said minimized ratio allows formation of a film comprising a selected stoichiometry; and

depositing said film over said gaps by using said gas mixture for simultaneous high density plasma chemical vapor deposition and sputter etching.]

performing an HDP-CVD process using the gas mixture to fill the gap with a dielectric, wherein the ratio of the oxygen-containing component to the silicon-containing component is substantially the minimum necessary to form the dielectric.

11. (Amended) The method of claim 1, wherein said [minimized] ratio is below approximately 1.2

12. (Amended) The method of claim 1, wherein said [minimized] ratio is between about 1.0 and about 1.2.

14. (Amended) The method of claim 1, wherein [said film] the dielectric is deposited over said gaps at an etch-to-deposition ratio between about 0.0 and about -0.05.

15. (Amended) The method of claim 1, wherein [said film] the dielectric comprises silicon oxide.

16. (Amended) The method of claim 1, wherein [said film comprises] the dielectric has a refractive index of about 1.46.

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19. (Amended) A method for filling <u>a</u> gap[s] during integrated circuit fabrication, comprising:

providing a gas mixture comprised of silicon-containing and oxygen-containing components;

selecting a flow rate of said silicon-containing component;

[minimizing] <u>providing</u> a <u>minimum</u> flow rate of said oxygen-containing component to allow formation of a film [comprising a selected stoichiometry] <u>having a refractive index of about 1.46</u>; and

<u>filling said gap by</u> depositing said film over said gap[s] [by] using said gas mixture for simultaneous high density plasma chemical vapor deposition and sputter etching.

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